

Iceberg Towing Experiments in the Barents and Kara Seas in 2016–2017

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This paper presents field results and analysis of iceberg towing experiments performed in the Barents and Kara seas in 2016–2017. Influence of oscillations during the towing process is demonstrated. For a wide range of towing speeds, drag force coefficients are determined for icebergs of various sizes and shapes. Simplified formulas for the iceberg towing force are proposed for the stationary mode. Formulas of long-period oscillations are also derived. The possibility of iceberg destruction by the vessel's circulation in warm water and long-distance iceberg towing is demonstrated.

INTRODUCTION

The possibility of changing an iceberg's drift trajectory in order to prevent its collision with offshore oil and gas facilities is an important factor for ensuring safe and economic developments in polar offshore regions. This approach is well known and has been used for several decades by oil companies operating offshore Newfoundland and Labrador (Randell et al., 2009). Timely detection (Pavlov et al., 2018) and towing of such giant and unsymmetrical objects as icebergs is associated with a number of specific features. Correct determination requires field tests and proper data analysis.

In order to test the technology of iceberg security under conditions of the Russian Arctic, the Rosneft Oil Company (Moscow, Russia) together with the Arctic and Antarctic Research Institute (AARI, St. Petersburg, Russia) and the Arctic Research Center (Moscow, Russia), performed field iceberg experiments with various technical means in the autumn periods of 2016–2017.

Experiments were carried out in the vicinity of the archipelagoes Novaya Zemlya, Severnaya Zemlya, and Franz Josef Land (FJL), with diesel icebreakers "Captain Dranitsyn" (expedition "Kara-Summer-2016," September 10, 2016–October 10, 2016) and "Novorossiysk" (expedition "Kara-Summer-2017," September 9, 2017–October 19, 2017), equipped with all necessary deck equipment (Fig. 1).

It should be noted that some limited efforts on iceberg towing in the Russian arctic were made by AARI in 2004–2005 (Stepanov, Gudoshnikov, and Buzin, 2005; Stepanov, Gudoshnikov, and Il'tchuk, 2005), while the 2016–2017 experiments discussed in this paper were more complex and successful.

The paper consists of three sections and a conclusion:

- Field experiments of iceberg towing: This section describes experiments performed, characteristics of the towing system, and parameters recorded during experiments, as well as the operation sequence during field trials.

- Analysis of empirical data: This section describes assumptions taken, processing algorithms, and observed oscillations during towing.

- Drag force coefficient determination for icebergs of various forms: This section defines the dependence of an iceberg's towing drag force coefficient on speed and linear dimensions, and proposes simplified formulas for calculating the required tow force on the iceberg's speed.

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